NASA Facts

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Mars Global Surveyor

NASA's Mars Global Surveyor, the first in a new series of spacecraft destined to explore the red planet, is preparing to intercept the orbit of Mars and begin a two-year mapping mission after a 10-month, 435-million-mile (700-million-kilometer) interplanetary journey.

The orbiter will fire its main engine beginning at 01:17 Universal Time on September 12 (6:17 p.m. Pacific Daylight Time September 11) for 22 minutes to slow its speed enough to be captured in orbit around the planet.

Mars Global Surveyor is a global mapping mission, carrying a suite of science instruments designed to study the entire Martian surface, atmosphere and interior. Measurements will be collected from a low-altitude, nearly polar orbit 234 miles (378 kilometers) above the Martian surface over the course of one complete Martian year, the equivalent of nearly two Earth years.

"Throughout its primary, two-year mission, Mars Global Surveyor will gather information on the geology, geophysics and climate of Mars," said Glenn E. Cunningham, Global Surveyor project manager at NASA's Jet Propulsion Laboratory, Pasadena, CA.

"The mission will provide a global portrait of Mars as it exists today," he said. "This new view will help planetary scientists to better understand the history of Mars' evolution, and will provide clues about the planet's interior and surface evolution. With this information, we will have a better understanding of the history of all of the inner planets of the solar system, including our home planet, Earth."

Mars Global Surveyor continues NASA's long exploration of the red planet, which began more than 30 years ago with the Mariner 4 spacecraft that produced the first pictures of the planet's cratered surface. Following the successful landing of the Mars Pathfinder lander and rover on July 4, 1997, Mars Global Surveyor is the first in a multi-year series of missions called the Mars Surveyor program that will lead to eventual human expeditions to the red planet.

Mars Global Surveyor was launched at 12:00:49 p.m. Eastern Standard Time on November 7, 1996, atop a three-stage Delta II launch vehicle from launch pad 17A at Cape Canaveral Air Station, FL. The third-stage Star 48B solid rocket later propelled the spacecraft out of Earth orbit and on its way to Mars.

Once on course for the cruise to Mars, the spacecraft deployed its two solar panels to begin generating solar power. One of the solar panels did not fully deploy and is tilted about 20 degrees from its intended position. The low-gain antenna was used for initial spacecraft communications, until the spacecraft was far enough away from Earth in early January 1997 to begin using its 5-foot-diameter (1.5-meter) high-gain antenna.

Mars Global Surveyor's six science instruments — the thermal emission spectrometer, laser altimeter, magnetometer/electron reflectometer, ultra-stable oscillator, camera and radio relay system — were calibrated during the cruise to Mars. Three trajectory correction maneuvers were performed to fine-tune the spacecraft's flight path. All spacecraft systems and the instrument payload performed well as Mars Global Surveyor headed for its destination, according to Joe Beerer, Global Surveyor flight operations manager.

When Surveyor reaches Mars, its 600-newton main engine will fire to slow the spacecraft's speed by more than 2,183 miles per hour (976 meters per second) with respect to Mars and allow the craft to be captured by Mars' gravity.

"Mars Global Surveyor will be flying over the north pole when it enters orbit around Mars," said Wayne Lee, Mars Global Surveyor mission planner. "The spacecraft will spend the first six days in this highly elliptical orbit around the planet, completing one orbit around Mars in about 45 hours, or just less than two days."

Instrument calibrations and some science measurements will take place during the elliptical orbit phase, said Dr. Arden Albee, Mars Global Surveyor project scientist.

“The spacecraft will be passing in and out of the planet’s magnetic field, if indeed Mars has one, during the early and larger elliptical orbits around the planet,” he said. “Global Surveyor will be able to make unique observations of interactions of magnetic field lines with the solar wind. In addition, it will make calibrations of the magnetometer and electron spectrometer that would not be possible from the lower-altitude mapping orbit.

“The thermal emission spectrometer and the camera will obtain initial observations on the surface and atmosphere of Mars,” Albee continued. “These will provide valuable insight into changes in the atmosphere that might affect the safety of the spacecraft during aerobraking operations.”

Six days after Mars arrival, the spacecraft will begin an innovative braking process, called aerobraking, to lower itself into a low-altitude mapping orbit. Aerobraking allows a spacecraft to use the drag of a planet's atmosphere to lower its orbit without relying on propellant. The technique was first tested in the summer of 1993, using the Magellan spacecraft orbiting Venus.

During each of its orbits shortly after Mars arrival, Mars Global Surveyor will pass through the upper fringes of the Martian atmosphere each time it reaches periapsis, the point in its orbit closest to the planet. Friction from the atmosphere will cause the spacecraft to be slowed slightly and lose some of its momentum during each orbit. Each time the spacecraft dips farther into the atmosphere, its one tilted solar panel will be rotated 180 degrees to protect it from folding up. As the spacecraft loses momentum, its apoapsis, or the point in its orbit farthest from Mars, will also be lowered.

Trimming its orbit from the highly elliptical, 45-hour orbit to a nearly circular, two-hour orbit will take about four months. Four engine burns will accomplish the first orbital adjustments, lowering the spacecraft from about 156 miles (250 kilometers) to about 69 miles (112 kilometers) above the surface.

Next, Mars Global Surveyor will spend about three months adjusting the farthest part of its orbit from 33,480 miles (54,000 kilometers) to about 1,240 miles (2,000 kilometers). As the spacecraft's orbit is trimmed, the time it takes to make one complete revolution around Mars will diminish to less than three hours.

In the final three weeks of aerobraking, Global Surveyor will raise the closest part of its orbit once again, until it is circling Mars in a 248- by 279-mile (400- by 450-kilometer) orbit, very close to the final mapping orbit. With this adjustment, the spacecraft will be orbiting Mars about once every 118 minutes, and crossing Mars' equator at about 2 p.m. local solar time each orbit.

As the spacecraft continues to circularize its orbit, the 110-foot (34-meter) antennas of NASA’s Deep Space Network will be used to begin a navigation and radio science experiment, measuring small shifts in the spacecraft's velocity that will tell scientists more about the planet's gravity field.

All of the spacecraft's instruments will be turned on around about March 10, 1998, and the mapping mission will begin on March 15. Data from this final checkout phase will allow the spacecraft to obtain one complete global map of the surface — a process that will take seven days — before the dust storm season begins in the spring.

"In 1998 the Martian dust storms occur roughly between February and August, so the atmosphere may be disturbed when mapping begins," Albee said. "But we may have an excellent opportunity to obtain data on the spread of a global Martian dust storm, should one occur next year."

In its final mapping orbit, Mars Global Surveyor will circle Mars at a speed of about 7,600 miles per hour (3.4 kilometers per second) in an orbit that will take it close to both poles. On the day side of the planet, Global Surveyor will be traveling from north to south. On each orbit, it will cross the equator at about 2 p.m. local mean solar time. The spacecraft will always see the surface of Mars on the daylit side as it appears at mid-afternoon. This “sun-synchronous” orbit puts the Sun at a standard angle above the horizon in each image.

Experiment teams will control their spaceborne instruments from their home institutions. Each 24 hours worth of data will be transmitted to Earth during daily, 10-hour tracking passes performed by NASA's Deep Space Network.

The Mars Global Surveyor mission is expected to yield more than 600 billion bits of scientific data, many times more the amount of data returned by all previous Mars missions, and exceeded only by the Magellan Venus mission.

Mars Global Surveyor will examine the entire planet — from the ionosphere, an envelope of charged particles surrounding Mars, down through the atmosphere to the surface and deep into Mars' interior. Scientists will glean valuable new information on daily and seasonal weather patterns, geological features and the migration of water vapor from hemisphere to hemisphere over a complete Martian year.

As the primary mission winds down in late 1999, Global Surveyor will be used to relay data from microprobes delivered beneath the surface of Mars by the 1998 Mars Surveyor Lander mission, and will be used as a backup relay platform for data from the Mars Surveyor '98 lander itself. Depending on its lifetime, Global Surveyor may also serve as a communications relay station for other spacecraft arriving at Mars.

Mars Global Surveyor is the first mission in a sustained program of robotic exploration of Mars, managed by the Jet Propulsion Laboratory, Pasadena, CA, for NASA's Office of Space Science, Washington, DC. JPL is a division of the California Institute of Technology.

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